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Analysis of the dynamical instability of several multiple stars with weak hierarchy

Zhuchkov R., Orlov V.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

The dynamical stability of 16 multiple stars is analyzed using Monte Carlo simulations with allowance for the errors in the observational data. The analysis was carried out by varying the uncertainties in the initial observational data. Six different stability criteria were considered, and the dynamical evolution was studied using numerical simulations. Eleven of the systems are probably stable, whereas five systems (HD 40887, HD 136176, HD 150680, HD 217675, and HD 222326) are probably unstable (the probability that they are unstable is 0.94 or more according to the results of forward and backward simulations over intervals of 106 yr). The results of the simulations were most consistent with the criteria of Mardling-Aarseth (the correlation coefficient between the probabilities of disruption inferred from the stability criterion and numerical integration was r = 0.998), Valtonen-Karttunen (r = 0.998), and Eggleton-Kiseleva (r = 0.997). In about 92-93% of all cases, these criteria yield results that are consistent with the numerical simulations. These criteria also yield high disruption probabilities for the unstable systems. Scenarios for the formation of such systems are discussed: temporary capture of a field star by a close binary, perturbation of a stable multiple system by a massive field object, and disruption of small stellar groups or clusters. The probabilities that these scenarios are realized are analyzed.

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